U.S. ARMY ORDNANCE

Technical Memorandum No. 10-57

HUMAN ENGINEERING PROBLEMS of the ARMORED PERSONNEL CARRIERS T113 AND T117

OCO, Research and Material Branch Project No. TB1-1000

human

ENGINEERING LABORATORY

ABERDEEN PROVING GROUND, MARYLAND

OCO, Research and Material Branch
Project No. TB1-1000

Report Number:
Technical Memorandum 10-57

HUMAN ENGINEERING PROBLEMS

of the

ARMORED PERSONNEL CARRIERS T113 AND T117

By

Albert S. Bacon - Donald R. Cronk

Anthony J. Rose

November 1957

APPROVED: John D. Weisz

JOHN D. WEISZ
Director
Human Engineering Laboratory

U. S. ARMY ORDNANCE HUMAN ENGINEERING LABORATORY
Aberdeen Proving Ground, Maryland

BLANK PAGE

C O N T E N T S

TABLES

SUMMARY AND INDEX OF RECOMMENDATIONS

HUMAN ENGINEERING PROBLEMS
of the
ARMORED PERSONNEL CARRIERS T113 AND T117
Conducted at Food Machinery & Chemical Corpn., San Jose, Calif., June 1957

DRIVER AREA

Vision

Within the driver's area there are a number of inter-related problems involving the seat, vision, accessibility, egress and working space. Adequate vision, of paramount importance to the driver, poses a problem for the short man driving in the up position. According to anthropometric measurements, the present distance from the seat, adjusted to the highest position, to the top of the hatch rim, falls short of the normal sitting eye height for 10% of the Army driver population, which means that they cannot see out of the vehicle. See Table I. As for the tall (95th percentile) man, his eye height above the rim is only 3.61 inches. It is obvious that the higher the eye height of the driver the less blind area there is adjacent to the vehicle and accordingly, the higher the eye level the better command he has of the terrain. Therefore, it is recommended that the maximum seat adjustment be raised at least two (2) inches thereby placing the median (50th percentile man) eye level 3.61 inches above the rim. However, it must be recognized that raising the seat height will accent the problem of reaching the accelerator pedal mentioned in page 5.

TABLE I - ARMY DRIVER NORMAL SITTING EYE HEIGHT

PERCENTILE	Distance: Seat to Hatch	Normal Sitting Eye Height	Eye Level from rim
5th	28"	27.72"	- .38"
10th	28"	28.11"	+ .11"
50th	28"	29.61"	+1.61"
95th	28"	31.16"	+3.61"

Head Clearance

Along with the problem of the short man's vision from the up position is the taller man's problem of head clearance when driving with the hatch closed, and the seat adjusted to the lowest position. Ten percent (the 90th percentile and above) of the Army driver population in a normal sitting height in the downmost position of the seat do not have enough head clearance from the closed hatch. See Table II. When the factor of arctic clothing is considered, which adds at least two (2) inches to normal sitting height, 65% of the Army drivers cannot clear the closed hatch. Therefore it is recommended, in order to accommodate the greater majority of Army drivers, that the minimum seat height be lowered.

TABLE II - ARMY DRIVER NORMAL SITTING HEIGHT (in inches)

Percentile Army Driver	5th	30th	50th	70th	95th
Distance Seat to Hatch	36	36	36	36	36
Normal Sitting Height	32.6	33.86	34.65	35.2	36.85
Head Clearance	3.4	2.14	1.35	.8	-.42
Arctic clothing factor	2	2	2	2	2
Head clearance with arctic clothing factor	1.4	.14	- .65	-1.2	-2.42

Seat adjustment

Another problem of the seat concerns the location of the pin which controls the forward and backward motion of the driver's seat. At present this pin is positioned on the left side of the seat where there is limited hand clearance between the seat and the side panel. It is recommended that this pin be relocated on the right side in a position which will not impair the driver's movement in and out of his seat (i.e., catch his loose clothing). With the horizontal release lever located on the right, the driver can make horizontal adjustments with the same hand he uses to adjust seat height.

Access-Egress

Access and egress to the driver area from the personnel compartment is extremely difficult due to the limited space between the seat backrest and the engine panel. Measurements taken reveal an eight (8) inch clearance from the right edge of the backrest to the panel and seven (7) inches from the widest part of the seat pan. This makes it necessary for the driver to squeeze in and out of his position. A way that the backrest could be made to swivel or pivot to the side would improve the situation and would increase the clearance between seat back and engine compartment panel to approximately fourteen (14) inches. It was also observed that the backrest was often taken out altogether on the prototype in order to facilitate access and egress through the compartment. This is not satisfactory as it was learned through troop interview in regard to the M48 tank (see Technical Memorandum No. 16 "Human Engineering Survey of the M48 Tank"). The men reported that when the seat back was removed it was usually lost or misplaced and therefore preferred a backrest that would pivot rather than be removable.

Distance to Controls and Pedals

Another problem with the seat involves the distance from the seat to the shift control lever which is out of reach for a large number of the population on the neutral position. Granted that this control is not constantly used, it would still be desirable to have all positions of this control located within easy reach of a driver seated in the open as well as the closed position.

Anthropometric measurements designed to accomodate 90% of the male adult population requires 25 inches for optimum fist grip reach to shift controls from the Seat Reference Point. The actual distance from the SRP to the neutral lever

of the shift control is 35-1/2 inches. Allowing 3 inches for the horizontal movement of the seat, the difference between optimum reach and actual distance to the shift controls is 7-1/2 inches. A driver can extend his shoulders 3 inches, which would reduce the difference to 4-1/2 inches; however, in view of optimum consideration, this is not desired.

Optimum distance from the driver's seat to the accelerator pedal constitutes another problem. The difference between the actual distance, as measured in the prototype and the optimum distance from the seat reference point to the accelerator is approximately 3 inches when the seat is at its lowest adjusted position and 10 inches when it is at the highest adjusted position. (See Table III). Therefore, recognizing that the accelerator pedal is one control which is imperative to operate continuously, it is recommended that this difference be reduced either by a greater forward seat adjustment or by repositioning the accelerator closer to the seat. It was previously recommended that the seat be raised to permit better driver vision from the open position, and by doing so without relocating the accelerator would further accentuate this problem. So it is further recommended that these problems, interrelated as they are, be corrected with due consideration given to each.

TABLE III- ACTUAL-OPTIMUM DISTANCE FROM SEAT TO ACCELERATOR

	Driver Position UP	DOWN
Actual distance: seat reference point to pivot of accelerator	38"	36"
Optimum for 90% accomodating heel contact	28"	33"
Difference from Actual and Optimum	-10"	-3"
Allowance (3") for seat adjustment	- 7"	0

Heel Support

There is not adequate heel support for the driver's foot on the accelerator. A heel support is recommended between one and 1-1/2 inches in depth for accelerator angles over 20°. The angle of the accelerator is 55° or 27° fully depressed and the present heel hold would not provide support for combat boots as worn by the field soldier. It is also recommended that the accelerator pedal be placed in such a position that a normal angle (i.e., 90° - 100°) between the lower leg and accelerator pedal be maintained to prevent undue driver fatigue.

Dimmer Switch

Another problematic situation concerns the location of the dimmer switch. Horizontal distance from the dimmer switch to the brake pedal is 1-1/2 inches; vertical depth is five (5) inches from the switch to the released pedal and one (1) inch when depressed. Assuming that the driver is wearing combat boots, accessibility to the dimmer switch in any case is seriously handicapped.

Also, the distance between the accelerator and the brake is two (2) inches which could permit slipping from the brake to the accelerator while applying the brakes with slippery boot soles.

Drainage

In conjunction with the seat, its location subjects it to the elements when the hatch is open or just cracked, or if the seals around the periscopes leak as they were reported to do on the M48 and M59. As a result, the seat, being concave, collects the water resulting from rain and snow. It is recommended that a drain hole be added to permit water to drain out of the driver's seat.

Warning Lights

A problem in the driver's area is created by the fact that the top of the steering wheel (in the up position) obstructs view of the warning lights when the driver is in the raised position. Both short and tall men cannot see these warning lights without shifting position. It might be feasible to alter the position or redesign the steering wheel so as not to block vision to the instrument panel. However, a recommendation, initially proposed in the M59 report, for a centrally located master warning light would be much more adequate. Driving in the up position makes it difficult to glance at the warning lights frequently; therefore ONE master warning light, located somewhere in the area within the driver's normal vision would allow the driver a closer check on controls. It should also be noted that this master warning light should have an adequate intensity so that it will be noticed when it goes on regardless of the bright sun and reflection on the outside and yet not destroy the driver's dark adaptation during night operations.

Communications Control

The communication control box, located to the front left of the commander, is difficult for the driver to reach. In the up position the driver has to bend back and adjust it by feel. Although it is not impossible to reach, the point to be made is that its position is not optimum for the driver.

Dome Light

Along with the control box problem is the location of the dome light which is placed directly in front of the commander, and therefore does not provide adequate illumination to the driver's area. A second light for the driver in his area should be added. This problem is elsewhere mentioned in conjunction with the crew area on page 9.

Vision Through Periscopes

Although the periscopes were not installed at the time of the field liaison study, measurements extrapolated reflect a problem similar to that of the M59, concerning vision through the periscopes. From a point twelve (12) inches from the periscope to the center of the driver's hatch, which is assumed to be a normal driving position, there is a 24° angle of blind area from the center periscope to the left periscope and a 14° angle to the right periscope. Leaning forward into one of the periscopes to obtain maximum unobstructed view will result in

overlapping fields of vision but this requires the driver to constantly shift his head from periscope to periscope.

It was found that there was a blind spot extending from the front of the vehicle outward approximately seven (7) feet. It is recommended that more adequate vision be provided for the driver from the periscopes.

In addition, this leaning forward close to the periscope subjects the driver to possible head injury by being thrown against the unpadded periscopes. Consequently the danger of bumping the head is very real. Some form of padding around the periscope is recommended.

Hatch Access

Access into the driver's area by the hatch would present a problem when the arctic-clothed 95th percentile soldier, who measures 22 inches at the shoulders, tries to pass through the 21 inch hatch. Shoulder breadth dimensions for 10% (the 90th percentile nude man - 19.19 inches) of the population with a two (2) inch addition for arctic clothing exceeds the diameter of the hatch rim.

COMMANDER AREA

The seat and cupola of the commander's area were not yet installed, thereby limiting a human engineering study of this area; however, a few potential problems became evident concerning accessibility to the radio, communications to personnel and to seat adjustment.

The radio, located to the left of the commander, appears to be beyond optimum reach. This problem would be accentuated with the commander in the up position. Besides reaching the radio controls the commander must be able to read the dials. When in the seat raised position, the commander must drop down to see them. In addition to being extra effort, he also loses temporarily his orientation to the outside situation when doing this. The ideal solution would be to have the radio located in such a position that it would be visible and within reach from the commanders up or down position. This problem for the commander in the up position existed on the M59. Additional comments on radio location are on page [illegible].

Access to the radio brings into focus the possible problem of seat adjustment. In order to operate the radio or communicate with the men, the commander must drop down from the up position, thus losing command of the terrain. Rapid adjustment up and down is vital to the commander; therefore, it is recommended that the seat be spring-loaded. It is felt that since the commander is responsible for the vehicle he should be accommodated as regards seating as well as the driver.

The problem of noise in commander-personnel communications is mentioned elsewhere (Page 10); however, this is a very real problem for the commander in that it may be imperative for him to issue commands while under motion before dismounting.

PERSONNEL COMPARTMENT

Headroom

The personnel compartment of the Carrier, Personnel, Full Tracked, Armored T113 and T117 will not allow comfortable seating for personnel above the 60th percentile when they are dressed in normal attire. Headroom in the T113 and T117 is 36.5 inches from seat pads, which are 1.5 inches thick. When dressed in arctic clothing (which adds at least two inches to a man's height) or combat gear (which requires an additional one inch to two and one quarter inches of head space because of the helmet liner and steel helmet) the range is lowered to the 45th percentile, which means that only 45 percent of the Army population will be able to sit comfortably in these vehicles. Personnel measurements may be found in Table V.

TABLE IV - NORMAL SITTING HEIGHT

PERCENTILE	INCHES	PLUS	ARCTIC CLOTHING
5th	32.6	2	34.6
25th	33.6	2	35.6
45th	34.5	2	36.5
60th	34.9	2	36.9
95th	36.6	2	38.6

Seating

Seats in the prototype model T113 and T117 were not equipped with backrests. The wooden mockup of the vehicle, however, had backrests of the type which will be installed in the prototype models. These backrests begin approximately one inch behind the seat and are approximately five inches high. They are tilted to allow the men to lean to the rear and provide support for their backs. This is a distinct improvement over the M59 in which the men had to lean against the hot engine access panels which were unsatisfactory as backrests. This same problem may, to a limited degree, exist in the T117 due to the exhaust duct located behind the seat in the right front of the vehicle. This problem should be examined to determine whether the heat from the exhaust will cause discomfort to the passengers riding in the front right side.

Bracing

It is obvious that straps suspended from the roof of a vehicle do not provide support for the torso and upper body when riding over rough roads or cross-country. Straps allow the body to turn and twist with each movement of the vehicle instead of supplying necessary support. It is recommended that the T113 and T117 be equipped with a permanent overhead bar type hand hold as well as seat belts of an instant disconnect type. These belts would supply support for the lower trunk and be an added safety feature to insure that men would not be thrown from their seats when maneuvering in rough terrain. The instant disconnect feature of the seat belt would insure that men could leave the vehicle quickly in the event of an emergency. These recommendations are based on answers to questions asked personnel on the

M59 and it is recognized that further study is necessary to determine the capabilities of seat belts. (See discussion contained in Human Engineering Laboratory Technical Memorandum No. 26 - "Human Engineering Survey of Armored Infantry Vehicle M59").

Personnel comfort may be impaired due to the placement of the heater in the right front corner of the personnel compartment, located directly in front of the side engine panel. This will cause a concentration of heat in the right side of the crew compartment due to the heat from the engine panel and the radiated heat from the sides of the heater.

It is recommended that the heater be relocated to reduce the heat concentration in the corner of the vehicle, and that the heater be examined to determine whether or not a cage or cover is necessary to prevent burning the personnel who lean against it by accident.

Floor Plates

Floor plates in the T113 personnel compartment are an aluminum nonskid material. These plates are satisfactory when they are dry but further study is recommended to find their characteristics when wet or spotted with grease, ice or snow.

Lighting

The light in the T113 and T117 is positioned so that it cannot be utilized to its best advantage. It is located slightly left of center in front of the commander. In this position the light in the crew compartment is effectively blocked by the commander of the vehicle. The driver can reach the light switch but only by twisting his body to the right and leaning out of position. It is doubtful whether the light coming into the driver's compartment will be sufficient for reading maps.

A recommended solution to this problem would be to have a light located to the left rear of the commander so that it will shine over his left shoulder, illuminating his maps and also provide the crew with enough light to assemble their equipment when the order is given. Another light in the driver's area and under his control would enable him to carry on his work.

Weapon Stowage

Stowage space for personal weapons is not available on the present model T113 and T117. Men questioned regarding this same area on the M59 regarded it as a problem during administrative moves. (See Human Engineering Laboratory Technical Memorandum No. 26.) Men stated that during such moves it would be desirable to have some provision made for their weapons so that they would not have to carry them on their knees or hold them at all times. A possible solution to this problem could be to mount rifle racks on the right wall of the hull.

Ventilation

Ventilation in the crew compartment is an important factor to be considered. In a present prototype model of the T113 there are fixed louvres in the cargo hatch which cannot be changed in position. As it exists now, these louvres are

in the open position. There is also a screen in the forward engine access panel which is used as an additional source for air for engine cooling. No provision has been made for closing this screen because air, coming in through the louvres in the cargo hatch and passing through the screen in the engine access panel, will create a desired natural draft. In summer this would not present a problem, but in cold weather this situation could cause discomfort to the personnel in the vehicle.

It is recommended that a system of adjustable louvres on the cargo hatch as well as a cover for the screen on the engine access panel, be installed so that incoming air can be regulated when the temperature demands it. In addition, in the event of CBR warfare, it would be important to seal the vehicle as much as possible.

Radio

The radio on the T113 and T117 is located on the left forward side of the personnel compartment above the battery box. It is directly behind the head level of passengers in the vehicle. During cross-country travel personnel may bump into the radio equipment with a possibility of changing the tuning or adjustment and damaging controls and/or dials. In addition, there would be a distinct possibility of injury to personnel. There is also a question as to whether personnel on the left forward side will interfere with the commander's use of the radio equipment. These men will be close together and will have on full field equipment and the space between them will be limited; consequently, they may be required to shift position when the commander must adjust the radio.

Noise

The problem of noise in the T113 and T117, as in the M59, is serious. In Table VI the decibel readings for various speeds on the T113 are shown. Table VII shows decibel readings from stated speeds and locations of the M59. It is to be noted that decibel readings from the T113 exceed, in each position, and at every speed, those taken in the M59. (See Table VIII). Decibel readings of this magnitude prevent conversation and discomfort is experienced by personnel subjected to this noise level. Temporary loss of hearing will occur, its duration depending on the length of time personnel are exposed to the noise at those intensities. It will be impossible for men exposed to this noise to hear or carry on whispered conversation and it is doubtful whether men, after eight hours or more of this noise could hear conversation or orders at the normal speaking voice level.

It is imperative that some means of reducing the noise level be incorporated into the vehicle so that orders can be heard and discomfort reduced. The possibility of installing a loudspeaker in the vehicle so that communication can be carried on between commander and squad, should be examined. This expedient has been tried on the M59 with success. A speaker would be effective as long as the volume could be raised to the extent that personnel could hear commands. (See Human Engineering Laboratory Technical Memorandum No. 26, page 26.) A set of warning lights, similar to the warning and jump lights used by airborne troops in their aircraft, could be used in the personnel compartment to inform the squad (1) when to assemble their equipment and (2) when the ramp is going down.

TABLE V - T113

	Crew Compartment					Driver's Area		
*MPH	L.F.	R.F.	L.R.	R.R.	C	DRU	CU	AVE
5	124	116	128	128	122	120	112	121.4
10	130	126	129	129	120	120	112	123.7
15	128	126	127	128	119	116	119	123.3
20	132	132	132	131	120	121	129	128.1
25	130	136	131	130	122	121	126	128.0
30	130	132	130	131	126	123	124	128.0
AVE	129	128	129.5	129.5	121.5	120.2	120.3	

TABLE VI - M59

MPH	Crew Compartment	Driver's Area	AVE
10	104	102	103
15	111	111.5	111.25
20	112	115	113.5
25	113	116	114.5
30	115	115	115.0
AVE	111	113.8	

TABLE VII - COMPARISON OF DECIBEL LEVELS BETWEEN T113 AND M59 AT STATED POSITIONS

	T113	M59
Crew Compartment	127.5	111
Driver's Area	120.2 (driver in up position)	113.8 (driver in down position)

* L.F. - Left front
R.F. - Right front
L.R. - Left rear
R.R. - Right rear

C - Commander down
DRU - Driver up
CU - Commander up

Ramp

The hydraulic ramp on the T113 and T117 presents an improvement over the ramp found on the M59 due to the fact that the ramp on the T113 has been hinged with a torsion bar on the bottom which allows it to be raised by only one man if the hydraulic system fails If the hydraulic system breaks down the ramp can easily be raised and locked in position. A problem arises, however, in that if the manual method is used the control cable would not be drawn up and, if the ramp release lever was accidently tripped, the ramp would drop freely. It is possible, due to the ease of closing the ramp manually, that personnel would be prone to substitute this faster means of closure for the slower hydraulic method. This would constitute a serious safety hazard.

It is recommended that the hydraulic control cylinder be equipped with a safety action which would draw up slack cable even though the hydraulic system was not in operation. This would prevent the ramp from dropping freely when the release lever was disengaged.

The surface of the ramp is coated with non-skid compound of a type which is not durable. The ramp does not have the metal steps welded to it as was found in the M59. The non-skid finish on the prototype model T113 was chipping or peeling off, leaving the ramp unprotected and the personnel subject to a safety hazard.

It is recommended that the ramp be coated with a permanent type non-skid finish.

The door in the ramp is 30 inches from the ground thus lowering the door 5 inches from the height of the door in the M59. This improves access which was a source of complaint among personnel in the M59, but it does not completely solve it. The recommended height for the door would be at the level of the knees, i.e., approximately 20 inches, so that when entering the door a man is not thrown off balance.

EXTERIOR AND MAINTENANCE AREAS

Access to the Top of the Vehicle

Access to the top of the vehicle is necessary for maintenance and entry to the vehicle through the driver's and commander's hatches. From the survey conducted on the M59 it was learned that steps or hand grips were preferred for this purpose.

At present the T113 and T117 provide several natural hand and foot holds. On the rear, the tow pintle, the external handle located in the middle of the ramp door and the top rear edge of the vehicle which is raised about two inches above the top plate all provide one means of access. Also on the T117 another natural foothold is available on the back side of the vehicle. A section of sponson that carries the shroud is recessed for design reasons and lends itself to be used in aiding personnel to mount the vehicle. On the front the tow eyes (or tie down eyes), the guards for the lights and the engine access door handle that is horizontal in the locked position also may be used for access. The sides of these vehicles provide no means of access since the shrouds cover the track and road

wheels, in the case of the M59, were found to be used as foot holds.

None of these available footholds are ideal and all would be a hazard to safety (as in the situation existing in the M59) if the surfaces are wet. Also, they are not positioned properly to allow use of them without throwing one's weight off balance.

To improve access from the front of the vehicle without adding any additional steps or hand grips, it is recommended that the tow eyes which could act as foot holds should have flat surfaces on top. At present they are rounded and are not satisfactory for this purpose.

The prospects of adding steps to mount the vehicle raised the question of its practicability for use in combat (i.e., it would be easy for the enemy to gain access to the top of the vehicle). Granting this point and also remembering that the vehicle would be used to a great extent administratively, it is recommended that hand grips and foot holds (that could be easily removed when and if the vehicle would be used in combat) be incorporated, preferably near the driver's hatch or near the gas filler spout.

Refueling

The long fuel filler pipe on the M59 is eliminated on the T113 and T117 due to the location of the fuel cell. This will help eliminate the problem of overflow due to expansion of the fuel and blow back due to improper venting. Access to the filler spout from the ground would present the only apparent problem.

The addition of hand grips and foot holds to aid mounting the vehicle (as mentioned above) would help this situation but locating the filler spout so that refueling could be done from the ground would be the ideal solution.

A provision for draining the fuel tank permitting accessibility and ease in performing this function is important especially in cold weather operation where draining condensation from the fuel is a frequently required maintenance task. The drain tube provided, however, should be long enough to extend through the ramp door so that the ramp does not have to be opened when the task of draining condensation from the fuel cell is required.

Exhaust Location

The exhaust of the T113 and T117 located to the right of the driver and commander is unsatisfactory in that engine exhaust and heat are blown into their faces by a cross breeze from the right when the vehicle is standing or moving. The heat is annoying, but the fumes could have a more serious effect such as poisoning the commander and even the crew members if enough of the fumes would drift inside through the opened hatch. Ideally, repositioning the exhaust to the rear of the vehicle or to the side would be the solution. But a more practical alternative, a shield acting as a baffle to force the exhaust and hot engine air away and to the side of the vehicle should be employed.

Tow Pintle

The tow pintle on the T113 and T117, located 23 inches above the ground and in the center of the vehicle, is not satisfactorily positioned when the vehicle is used as a prime mover for the 105mm howitzer. On the M59 the tow pintle was mounted approximately 30 inches above the ground and here it was reported that the spades on the trails of the 105mm were dragging and scraping when it was being hauled over rough terrain. This was especially true in Alaska where the M59 was utilized as a prime mover and much of the movement was cross-country.

There is no practical solution to this problem for the T113 and T117 because of the present location of the rear door. The door might be raised to allow higher positioning of this pintle but this is not recommended because access to the vehicle through the rear door would then be impaired. (See page 12). The prospects of moving the rear door to one side of the ramp were investigated but the width of the ramp is not great enough to permit the same sized door and also have the center of the vehicle free so that the pintle can be raised along a vertical axis.

Suspension Maintenance

Lubrication of the T113 and T117 is very satisfactory from the point of ease of accessibility. The addition of the plastic plug, making a visual oil level check of the road wheel bearing lubricant possible, is recommended from the human engineering view point. The location of the final drive filler and drain plugs are ideal for accessibility but because of this location they are readily susceptible to damage which would make them difficult to remove, i.e., the edges of the plug head would be stripped and rounded making it difficult to remove with a standard wrench. Perhaps using steel plugs instead of aluminum ones would help eliminate this condition but relocation would be the only real answer. In relocating, consideration of accessibility of these plugs would then have to be taken into account.

Adjusting track tension on the T113 and T117 presents several problems that would give some trouble to maintenance personnel. The location of the track tension locking arm and tension locknut is normally very good for access providing the experimental wheel employed on the prototype is not used. The track tension adjusting pin (i.e., the pin that the cable is placed around in making track adjustment) is so positioned that a minimum of clearance is available to allow the installation of the cable around it. With the specified cable it is satisfactory but if ice, snow, or dirt further limits this clearance the cable could not be readily positioned. This situation would be true especially in cold weather operation. It is therefore recommended that a greater clearance be allowed.

Engine and Transmission

Maintenance of the T113 air cooled engine and the T117 liquid cooled engine is relatively simple from the point of view of accessibility. It was noted, however, that on the T117 access to the right of the engine is somewhat limited especially while the exhaust manifold pipes are hot.

During cold weather operation in places such as Alaska, frequent oil level checks are required because of the extremely light weight lubricant used. It would therefore be advantageous to have a hinged inspection plate in the access panel next to the driver. This would enable the driver to easily check the oil without removing the entire panel. Latches for any inspection plate or access panel must be designed to permit easy manipulation with arctic handwear.

Access to the engine from the front of the vehicle is satisfactory. There was some question as to the advantage of adding a step, permanent or temporary, that could be used while maintenance was performed through this portal. The height of the lower edge of this access door to the ground is 53 inches and accordingly would permit access to the transmission oil check by a man in the 5th percentile group.

If a permanent step were added here it would be easily knocked off and if a removable step were used it would be easily lost. Therefore, it is the considered opinion that as long as access is attainable for minor maintenance no step be added. For extended maintenance a make-shift step could easily be obtained and utilized.

If a trim vane is to be incorporated on the T113 and T117 it will be important to note that access through the front engine access door will be impaired from the ground unless design consideration is given. Access to this door from the top of the vehicle is definitely not recommended as an alternative with the addition of this trim vane.

The two universal joints of the final drive on the right side of the vehicle and one on the left side are readily accessible for lubrication through the front access door. The second universal joint on the far left is located underneath the driver's toeplate. The only means of gaining access to this point is by completely removing the plate. It is therefore recommended that a section of this plate be cut out so as to permit ready access to this lubrication point without any disassembly.

To simplify lubricating these universal joints it is recommended that two grease fittings be employed (i.e., one more than is now used) 180° apart. This would enable greasing regardless of the position of the shaft when the vehicle was stopped.

FOLLOW - UP REPORT
HUMAN ENGINEERING PROBLEMS
of the
ARMORED PERSONNEL CARRIERS T 113 AND T 117
Conducted at Yuma Test Station, Yuma, Arizona, August 1957

DRIVER AREA

The problems found in the driver's area of the personnel carriers T113 and T117 are presented in this segment of the report. Comments and recommendations have been made after all sections of this compartment have been examined.

The T113 and T117 are not equipped with locks on the outside of the hatch. The driver of the vehicle cannot lock it from the outside to prevent pilferage of OVM as well as possible destruction of the vehicle.

Inside the driver's hatch, the latch used to secure this hatch in the "buttoned up" situation may cause injury to the driver unless extreme caution is exercised. This latch, located slightly to the left of the periscope, may be dangerous if the driver leans forward to look through the periscope, or, if in adjusting his seat, he pulls himself forward and leans toward the front.

Closing the hatch on the driver's compartment presents another problem. The hatch is held in the open position by a safety catch which must be released. The handle, used to pull the hatch closed, is on the side opposite the safety catch. To shut the hatch, it is necessary for the driver to stop, come out of the hatch facing the rear of the vehicle, and use both hands. First he must release the safety catch; then using his other hand, he must grasp the handle and pull the hatch closed. These movements expose the driver to enemy fire. Locating the hatch handle on the same side as the release catch, thus requiring the use of only one hand and cutting down the time of exposure, is a recommended solution. Arranging the hatch mechanism to allow the hatch to be closed from inside the vehicle would also solve the problem.

Another problem in the driver's area is the location of the M17 periscope. When the driver is in the up position, he is unable to see the gages showing engine oil pressure, fuel level, and battery charge because of the periscope. It was noted in the Initial Report, Human Engineering Problems of the Armored Personnel Carriers T113 and T117 that the steering wheel, when in the up position, obscures the warning lights on the bottom of the instrument panel. The driver must be warned when there is a failure in the system and, if the instruments are to be of value, they should be placed in such a position that he will see them.

The instrument panel should be placed so that it is easily seen by the driver in the up position since a great deal of the driver's time is spent in this position. The location of the panel should not compromise the driver's view of the instruments when he is "buttoned up" in a combat situation.

The Initial Report on the T113 and T117 mentioned that the light in the personnel compartment was not satisfactory for the driver. It is recommended that a light be installed in the driver's compartment on the left side. This light, like the one in the crew compartment, should have both a red safety light and a

white light. A safety catch should prevent turning on the white light accidentally.

It is difficult, if not impossible, for the driver to leave the vehicle through the personnel compartment without his bumping the seat back, seat pan, or ramp release mechanism. To prevent this difficulty the driver's seat could pivot from the left side panel. Then, when leaving the vehicle, the driver could simply push the seat against the left wall of the vehicle, leaving an open space through which he could move.

When the seat is in the farthest back and highest position, the driver is forced to lean against the hatch rim. The seat back rest is behind the hatch rim, and, in this position cannot be utilized.

All controls requiring frequent handling by the vehicle operator should have some type of temperature resistant insulation to prevent burning hands or feet during hot weather operations or to avoid having flesh stick to exposed metal parts during cold weather operations.

COMMANDER AREA

The area used by the vehicle commander in the personnel compartment of the T113 and T117 was studied to determine whether problems existed and whether recommendations could be made to allieviate them.

The commander's seat is attached to a post in the center of the personnel compartment facing the front of the vehicle. Below this seat is a platform which, like the seat, is adjustable in its distance from the floor. Another seat for a squad member is attached to the back of the post which supports the commander's seat. The back rest for the squad member's seat is attached to the commander's seat and moves as the commander adjusts his seat. When the crewman's seat pan is in the lowest adjustment and the commander is in the up position, the back rest for the crewman will be of no use. The back rest will be approximately at the level of the top of the crewman's head. It should be noted that any adjustments in the height of the crewman's seat will probably be made before the vehicle is in motion. The commander, however, may be adjusting his seat for the open position and later for the "buttoned up" position.

Since the commander's hatch presents the same problem as the driver's hatch, the same solution is applicable. In closing the commander's hatch, two hands are necessary; one releases the safety catch and the other grasps the handle and pulls the hatch shut.

PERSONNEL COMPARTMENT

During the work on the T113 and T117 it was found that there were several areas in the personnel compartment which required study and recommendations.

The battery box, located on the left forward wall of the personnel compartment, is covered by a metal top held in place by snap latches. If cartridge

belts or clothing open the latches, the top of the battery box could come off. With the top of the battery box off the batteries would be subject to accidental damage and the top of the box could be dented and unfit for use. The radio in the T113 and T117 is located so that personnel seated in front of it will tend to bump against it with their heads and necks while traveling over rough terrain. This problem was mentioned in the Initial Report. It is brought up here to re-emphasize that problems, for example, the changing of settings on the radio by hitting the dials or the injury to personnel riding in the vehicle, could arise.

Ammunition for the .30 caliber machine gun is stored upright, in regulation ammunition boxes, under the personnel seats. It would be necessary to raise the seats to get at the ammunition boxes or, with the seats down, the men would have to fumble to remove the tops of the boxes. If tie-down straps are used, there is an additional problem.

Two or three men seated on each side of the platform on the commander's seat will not have leg room or free movement. Such a situation is uncomfortable during travel and, since the edge of the platform hits the leg between ankle and knee, there is a possibility of injury not only while riding but also when leaving the vehicle.

EXTERIOR AND MAINTENANCE AREA

The trim vane, when in the down position, interferes only slightly with access to the engine compartment through the access door.

The tow eyes found on the T117 at Yuma Test Station were found to be much more advantageous for access to the top of the vehicle than those previously found on the vehicles. These tow eyes were rounded off to provide a natural foothold. It is recommended that this same process be used on all future models of the T113 and T117.

REFERENCES

McFarland, Ross A. Et. al., Human Body Size Capabilities in the Design and Operation of Vehicular Equipment Harvard School of Public Health Boston, Mass. 1953

Ely, Jerome H., Thomson Robert M., Orlansky Jesse., Layout of Workplaces Chapter V of the Joint Services Human Engineering Guide to Equipment Design, Dunlap and Associates, Inc. Wright Air Development Center, 1956

Kobrick, John L., QM Human Engineering Handbook Series: Spatial Dimensions of the 95th Percentile Arctic Soldier QM R&D Center US Army Natick, Mass. 1956